

A case study on the feasibility of shipping container homes as housing for disaster victims

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Abstract

This case study is designed to examine the feasibility and possible implementation of the use of modified steel shipping container units, as temporary relief housing for victims of natural disasters. In this study we will analyze an on-going shipping container project being constructed in Santa Rosa, CA as well as use previously constructed research on this type of construction. The point of this research is to develop and analyze areas in which shipping container projects like this one could be more expeditious and more cost efficient in the future. In short, my findings proved modular shipping container home construction, as a form of natural disaster relief housing, is faster, cheaper and just as safe as traditional ground up construction.

Key Words: Case Study, Shipping Containers, Temporary Housing, Disaster Victims, Permitting

Introduction

My original interest with this topic began when my hometown, Santa Rosa suffered one of the most devastating fires in California history, the “Tubbs Fire” that began during the night of October 8, 2017. This wildfire was extremely devastating and has been deemed the second most destructive wildfire in California’s history. Over 6300 homes were lost due to the blaze, of which were many friends and family members homes. Kaikaina Construction Inc. decided to help with the urgent housing needs of those who were affected in our area. They decided to use six steel shipping containers to construct modular, temporary housing for one family friend that had been lost their home in fountain grove due to the Tubb’s fire. This temporary house was meant to provide them with more “permanent housing” so they could relocate out of their relative’s house during the period it would take to reconstruct their home. It was to be constructed in a modular manor in a way that once they no longer needed it, that it could be dismantled, sold and shipped to another area to serve as temporary housing again. This report discusses the trials and tribulations of this particular project as well as informing the reader of ways in which this type of construction can be massively beneficial for disaster victims; both in cost effectiveness and expedience.

What happened?

On October 8th, 2017 at 9:43 PM, a fire was started in Calistoga due to a malfunction of a home's exterior electrical system. The fire moved extremely fast, rolling over Mark West Springs Road and into Santa Rosa in less than 3.5 hours. The fire was able to move so incredibly quickly and destructively through this area due to very severe wind and humidity conditions that were present. It was recorded that the fire was spreading at a burn rate upwards of an acre a minute, with 50 mph winds throwing large smoldering particles up to a quarter mile; the perfect storm. All said and done the fire wiped out 5,200 structures, most of which were homes. The fire killed 23 Santa Rosa residents and injured countless others. The fire also displaced more than 20,00 residents, causing a massive housing crisis, which has now manifested into an impenetrable housing market, causing many of those who were affected to relocate elsewhere and find new work. On top of this devastation, many of those who were affected, are now having extreme trouble finding contracting companies that have time to build their house, and many have been forced to sell their land and move.

Below are some images that help to provide some scope to the truly destructive and encompassing nature of this event.



Figure 1.0
Coffi Park, Santa Rosa, CA aerial picture of before and after the Tubb's Fire Disaster



Figure 1.1

Infrared satellite photo of the fire line in Santa Rosa, CA on October 9th, 2017

Background Information

Steel shipping containers in all different sizes have been used to store and ship things since the early 1940's. They come in various sizes, colors and thicknesses, and have been used to make many different kinds of structures. Although they're original designed purpose was to use as cargo containers for freighting, they have become very popular in today's urban and contemporary structure market. They are extremely well suited to handle exterior forces due to their rigid design and all steel elements. Although the use of shipping containers as a method of residential construction in CA is somewhat unpracticed, it is widely used in other areas of the country as well as other areas around the world for many different purposes. All around the world shipping containers are being used and some are simply sitting idly by, unused while many more are being produced. By integrating these unused shipping containers into the construction industry, you could recycle a tremendous amount of steel, therefore also limiting the amount of traditional resources such as Steel structural members, timber members and wood. This form of construction is a perfect example of adaptive reuse, by taking shipping containers that not being used, and transforming them into emergency housing.

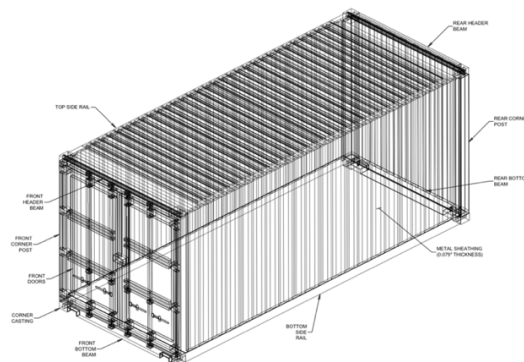


Figure 1.3

A 3D model of the exact shipping container model we used for the construction of the home

Some example structures have been attached below in order to give the reader a sense of what these projects look like and what the overall dimensions might be (Figures 1.2-1.4)



Figure 1.2

Single 20', one bedroom, one bath shipping container home constructed in Napa, CA



Figure 1.3

Single 20' contemporary studio developed on AutoCad for advertising purposes

Methodology

Data for this report has been collected in both qualitative and quantitative natures in order to develop and examine the “whole scope” of the topic. Much of the current building plans and pictures of the project have been added to the senior project binder for reference. Many pictures have been taken of the site through several different stages of the construction process as well in order to provide a sense of scope and timeline. Interviews were conducted with the owner, the general contractor, and the lead engineer in order to have a well-rounded and comprehensive explanation for what has gone well and where improvements could be made in order to make this form of construction more feasible for a larger population of disaster victims.

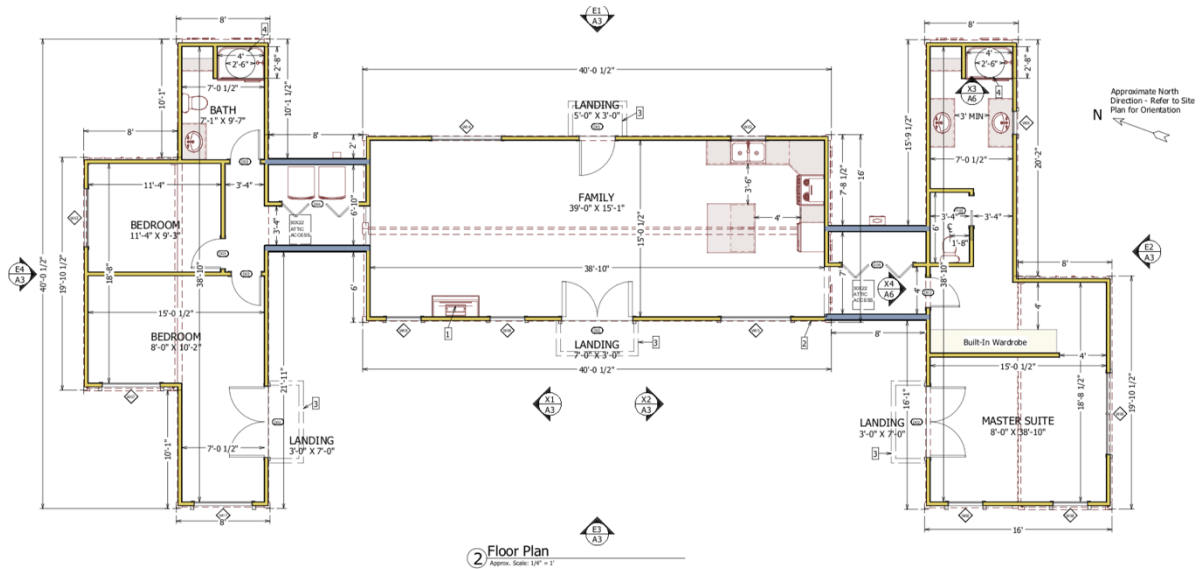
The objective of this case study is to:

- Inform readers of the massive need for quick and cost-effective temporary disaster relief housing.
- Examine the specific Santa Rosa project and analyze its effectiveness and the feasibility of possible duplication in the future.
- Analyze and explain the areas in which this type of construction is positive, negative and areas that could benefit from further improvements.

Overview of the project

The project that was the center of this case study was a residential home, constructed by *Kaikaina Construction Inc.* in Santa Rosa, CA. *Kaikaina Construction* was the General Contractor, *Precision structural engineering Inc.* was the lead structural engineer. The project consisted of six (6) 40’ steel shipping containers, and the overall living space was approximately 1,600 square feet. The home itself was designed as a three-bedroom house with an open floor plan. The projected timeline for completion of the project was 5 months, however, due to permitting setbacks, it ended up being 8 months. The overall cost of the project was also affected by issues due to permitting and delays. The original estimate for the project was \$115,000 and the actual cost of the job was, \$144,000. The purpose of this project was to help house a family that had lost their home in Fountain grove; therefore, the job was operating under an accelerated timeline in order to accommodate them as soon as possible.

Photos of the plans have been attached below in order to help visualize the project. And also, for your reference, all photographs as well as both structural, architectural and Geotechnical plans have been compiled in the binder that accompanies this report.



*Figure 1.4
Floor Plan from Architectural plan set (Creative Touch Home Design/ Precision Structural Engineering Inc.*

What are the positives?

- The use of shipping containers in construction allows construction to take place in a more expeditious manner.
- This type of construction can be built modularly, which allows them to be taken apart and moved around, making them a great option for temporary housing; and in this way, shipping container construction is one of the most versatile forms of construction for emergency situations.
- This form of construction is often much more cost effective than traditional ground up construction.
- The inherent strength and ability to withstand large external forces put on these steel shipping containers provides for a very strong starting block for constructing a structurally sound building.
- It is an eco-friendly way of constructing since it recycles shipping containers that were already in circulation; one 40' shipping container recycles roughly 8,000 pounds of steel. Using these unused containers is a great example of adaptive reuse.

- This form of construction relies heavily steel shipping container units to provide wall “framing structure”, which ultimately limits the use of natural resources that are usually associated with traditional construction methods.

What are the negatives?

- This type of construction can require extra permitting or cause delays due to permitting issues if you are building in areas that are unfamiliar with modular construction methods.
- Sometimes this form of construction can require more design consideration when dealing with running utilities such as water lines, electrical lines, stub outs, and HVAC piping inside the house due to limited, if any, wall and attic space.
- Areas such as the roof which are not as structurally sound as the sides of the container will almost always require additional reinforcement, especially when building in areas that accumulates snow.
- When cutting windows or entrances into the side of the containers, this weakens the structural integrity, therefore you must provide additional reinforcement in these areas to make up for the lost rigidity.

Possible Future Implementation

In light of the information that has come from this case study, external research and experience with this form of construction, I think that this form of construction is very feasible for either quick emergency situations where time is of the essence, or when a project requires a more contemporary and artistic design. In fact, shipping container projects are widely used around the nation as modern residential construction, in the food and entertainment industry as well as commercial construction. And to narrow the conversation back down to providing temporary housing relief, this form of construction is also widely used in areas around the globe such as Haiti and as temporary housing structures for people displaced by disasters. There is also already in place a market of prefabricated container homes, in which people can customize the units to serve their needs and receive their modular home in as little as six weeks. This market of prefabricated modular home units is really the most feasible utilization of this method of construction. These pre-fabricated modular units could prove to be an invaluable asset to organizations such as FEMA, where in they could purchase a large number of these units designed for single families and ultimately provide safe, comfortable, temporary housing to a massive population of disaster victims.

Conclusion

After analyzing the particulars about my specific case study as well as other supporting articles, the implementation of shipping container homes in cases of disaster relief is a very feasible option. Unfortunately, in this modern climate, the fact is that it's not a question of if natural disasters like the Tubb's fire will happen, but when? Although this particular case study had numerous set-backs due to its somewhat over complicated design and issue with permitting, downsizing to single unit construction would be able to fast, safe and comfortable housing to future disaster victims. In summation, the benefits that shipping container home construction are that it recycles existing materials, it is a faster way to build, and it is very often a cheaper way to build a home saving on traditional building materials and added labor. And for these reasons, this form of construction makes for effective and expedient housing for disaster victims. There is a lot of information that is still unknown, regarding permitting as well as possible interest from such organizations such as FEMA to adopt this form of housing disaster victims, and for future research, that would be the most beneficial research to start with.

References

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